Squally Beach: Challenges of Urban Restoration

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Abstract

The Commencement Bay Trustees selected Squally Beach as a habitat restoration site because it was in a relatively unimpacted area of the heavily industrialized of the Tacoma Tideflats. A corner of the site supporting a lush bed of *Carex lyngbyei* hinted at the potential for a small but thriving upper salt marsh environment. Stormwater flowing under the site through culverts offered the possibility of mixing fresh water with salt water to increase the variety of plants that could be grown.

Ridolfi Engineers led a team that developed two conceptual designs intended to maximize the area at appropriate elevations and use the fresh water throughout the site. Other considerations included potential for use of the site as a nursery, beach stability and passive public access. Public input was solicited in Trustee meetings and incorporated into the final design. Permitting was a challenge because regulators have a difficult time fitting restoration projects into the existing process. Construction provided additional challenges but the project was successfully implemented in the end. Public involvement will drive the next phase of the project as both upland and salt marsh plants will be installed by volunteers. A biological and physical monitoring program has also been developed to evaluate habitat function over the next decade.

Introduction

The Commencement Bay Natural Resource and Damage Assessment (NRDA) Trustees are mandated to identify environmental injury, assess damages and restore the environment in areas impacted by contamination (Commencement Bay NRDA Trustees, 1997). This report summarizes restoration work performed at the Squally Beach site in Tacoma, Washington on behalf of the Commencement Bay NRDA Trustees (Trustees) (Figure 1). The Trustees include the National Oceanic and Atmospheric Administration (NOAA), the U.S. Department of the Interior (U.S. Fish and Wildlife Service), the Puyallup Tribe of Indians, the Muckleshoot Indian Tribe, the Washington State Department of Ecology (lead agency for the State), the Washington State Department of Natural Resources, and the Washington State Department of Fish and Wildlife.

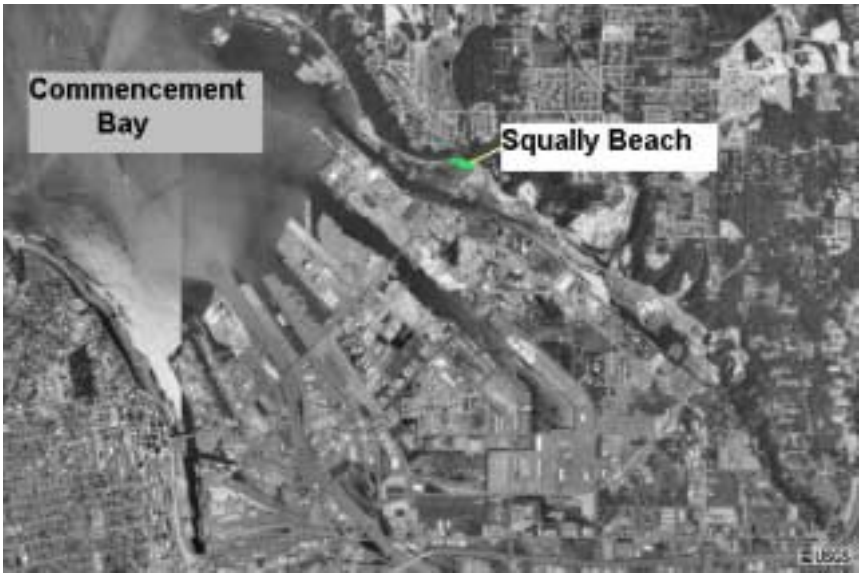

Figure 1 Location of the Squally Beach Site.

Ridolfi Engineers Inc., the design engineers for the project, worked under contract to NOAA, which served as the lead NRDA Trustee. Design efforts were performed by a team that included Ridolfi, Osborn Pacific, Inc., Adolfson Associates, Inc., EVS Consultants, Inc. and the Battelle Marine Sciences Laboratory. Remtech, Inc. (Remtech), the construction contractor for the site work, performed the restoration work under direct contract to NOAA.

Site Description

The Squally Beach site, previously known as the Puyallup Tribal Nursery site or the Puyallup Tribal Conservancy and the Inner Hylebos site, is located along the northern shoreline of the Hylebos Waterway, south of Marine View Drive and immediately west of East 11th Street. The project site consists of approximately 0.66 acres of uplands adjacent to the largest remaining mudflats (about 60 acres) in Commencement Bay (Commencement Bay NRDA Trustees, 1997).

Prior to restoration, the Squally Beach site contained hardwood trees, blackberry bushes, and a strip of intertidal salt marsh vegetation approximately 3- to 4-feet wide growing at approximately the mean higher high water (MHHW) elevation. The salt marsh vegetation and low-gradient mudflats provide habitat for bottom-dwelling organisms important to the food web. These organisms are of particular importance to shorebirds and juvenile salmon. The upland portion of the site was covered with blackberry bushes and other invasive plants.

Portions of the site were paved with asphalt pads indicating the presence of historical structures. The site contains several pilings, logs, and downed wood indicative of previous log storage activities in the vicinity. More recently, refuse had been indiscriminately dumped at the site due to convenient access from Marine View Drive.

Goals and Objectives

As articulated on a fact sheet prepared for the site, the Trustees' primary goal for Squally Beach was to establish an intertidal plant nursery to provide native plants for use in Trustee restoration projects (NOAA, 1998). However, discussions with the Trustees held in early 1999 indicated that expansion of the existing salt marsh vegetation at the site was the primary goal for the project, and that establishing a viable plant nursery was a secondary concern that should not be pursued to the extent that the primary goal is compromised. For example, the Trustees recognized that providing access for harvesting operations would reduce the area available for restoration.

The design team expanded on the goals identified by the Trustees to include habitat creation for small mammals and birds. This could be accomplished by intercepting and using fresh water from two stormwater discharges that cross the site in a channel or channel and pool system. Additionally, the design team wanted to create more passages from the site to the mudflats area that could convey food such as insects and detritus for use by out-migrating salmonids. This could be accomplished by establishing food source areas such as riparian zones adjacent to the channel system, which would capture materials falling from overhanging leaves and branches.

The Trustees selected a dendritic channel alternative for the Squally Beach site. The Trustees selected this alternative based on a desire to maximize production of salt marsh vegetation. Important considerations for this alternative are:

- Distributing fresh water across the project area as uniformly as possible to maximize the area where high salt marsh plant species can thrive.
- Protecting existing salt marsh vegetation.
- Reducing negative anthropogenic impacts to the site by limiting site access.

Studies and Design

Topography
The City of Tacoma Engineering Department performed a topographic survey of the Squally Beach site to provide a basemap for design efforts. The map was referenced to the National Geodetic Vertical Datum (NGVD) of 1983. Subsequent mapping was performed relative to mean lower low water (MLLW), a tidal datum used in marine and nearshore environments. A shift of plus 6.32 feet, which is appropriate for the Tacoma area, was used to make this translation. In other words, an elevation of 0.0 on the NGVD datum was adjusted to +6.32 on the MLLW datum.

Soils
In June 1999, EVS completed six hand auger borings at the site to observe soil conditions. The depths of the auger holes ranged from 0.7 to 5 feet. The top two or three feet consisted of gravelly sand with silt. Below the top two or three feet, the soil generally consisted of silty or clayey fine to medium sand. In the eastern portion of the site, the lower soil contained wood debris mixed with the sand.

Vegetation
The upland vegetation at the project site consists of grasses, shrubs, including Himalayan blackberry (*Rubus procerus*) and Scot's broom (*Cytisus scoparius*), and trees, including red alder (*Alnus rubra*) and a few small fruit trees. Salt marsh vegetation fringing the mudflats consists primarily of seashore saltgrass (*Distichilis spicata*), Lyngby's sedge (*Carex lyngbyei*), pickleweed (*Salicornia viginica*), seaside arrowgrass (*Triglochin maritimum*), and three-square bulrush (*Scirpus americanus*). Batelle Marine Sciences Laboratory Design conducted a survey of salt marsh vegetation in Commencement Bay for the Trustees (Thom et al., 2000). In the survey, the elevation and percent cover of various species were noted and plotted (Figure 2). These data were used in the design process to select appropriate plant species for the project.

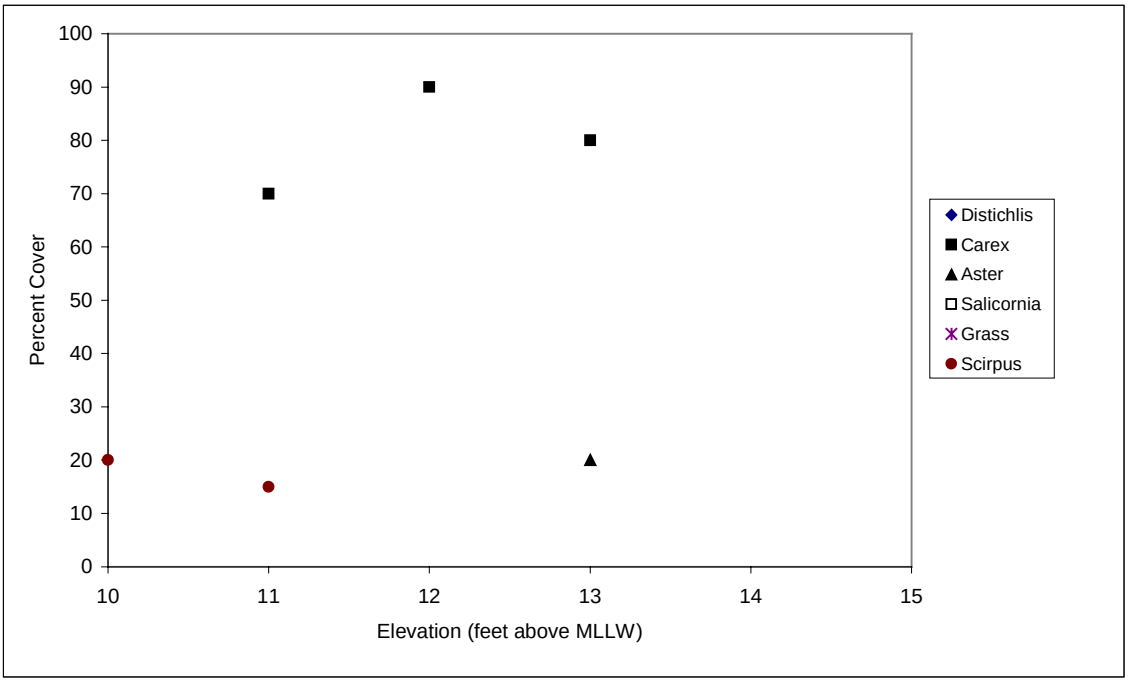

Figure 2 Distribution of salt marsh vegetation at the Squally Beach site (Thom and others 2000).

Hydrology
Based on preliminary field observations, the hydrology of the site is influenced by tidal elevation fluctuations, surface freshwater inflow from two stormwater outfalls, and ground water seeps. The following paragraphs provide a brief description of each of the factors influencing the hydrology of the site.

Tidal elevation and range at the site are assumed similar to observations from a tide gage located near downtown Tacoma. The lowest elevation at which rooted intertidal vegetation was observed is approximately 8 feet, relative to MLLW. During the period, over which tidal elevations were evaluated (March 1 through August 31 from 1994 through 1998), the tidal elevation exceeded 8 feet approximately 34 percent of the time.

Surface fresh water was routed across the site through two stormwater outfalls that drain an area of approximately 12 acres. Both outfalls directed stormwater through the project area and discharged into the intertidal mudflats, one directly through a 12-inch concrete pipe, and the other through a 12-inch concrete pipe and into a short, narrow, incised channel flowing into the mudflats. The westernmost of the two outfalls discharged runoff from Marine View Drive and the steep, forested slopes north of the site. The eastern outfall discharges runoff from Marine View Drive, runoff from the slopes north of the site, and runoff from paved commercial areas east of the site along East 11th Street.

The City of Tacoma conducted an analysis of the quantity and quality of water being discharged to the Nursery Site from the two outfalls (Stetson, 2000). The estimated rate of flow from the western and eastern outfalls was 15 gallons per minute (gpm) and 20 gpm, respectively. The water quality of both outfalls was good. Ridolfi Engineers performed a hydraulic analysis and determined that installing rock outlet structures to replace the outfalls would not create unacceptable backwater conditions (Ridolfi, 2000a).

Based on field observations, groundwater appears to be discharging through seeps along the eastern margin of the project site. It is possible that the seeps support wetland vegetation above the intertidal areas of the site. Groundwater was encountered approximately three feet bgs in a test pit excavated on the eastern side of the site.

EVS collected soil samples in support of restoration design at the Nursery Site in 1999. The purpose of the sampling was to characterize overburden soil and soil at the anticipated post-excavation depth. Based on the sample analysis results, no contamination above residential cleanup levels was detected in any samples collected from the site (EVS, 1999).

Site Layout and Design
The design for the Squally Beach site included grading to allow salt marsh development between elevations of +10 and +13 feet MLLW (Figure 3). An estimated 2,300 cubic yards of fill required removal to achieve these grades. A fringe of riparian plants was selected for elevations between +13 and +18 feet MLLW. This included construction of a berm parallel and adjacent to Marine View Drive to act as a visual and physical buffer. Figure 3 also shows the locations of toe logs that were intended to resist erosion. Additionally, the rock boxes and associated channel systems are indicated on the drawing. Erosion mat, fabricated from coconut fibers, was also included in the design to help hold soil in place until roots are established. The erosion mat will also collect and retain seeds that might otherwise wash off the site onto the mudflats.

Permitting
Permitting for the site was slightly simplified relative to other restoration because the work was conducted on land held in trust for the Puyallup Tribe. This eliminated grading permits that would otherwise have been required from the City of Tacoma. Adolfson Associates Inc. handled the permitting requirement by preparing a Joint Aquatic Resource Permit Application (JARPA) and preparing a biological assessment of the project for section 7(c) compliance under the endangered species act (Adolfson, 1999a). Adolfson also prepared an Environmental Assessment for the project (Adolfson, 1999b). Additionally, a set of the construction plans and specifications were provided to the Puyallup Tribe for environmental review (Ridolfi, 2000b).

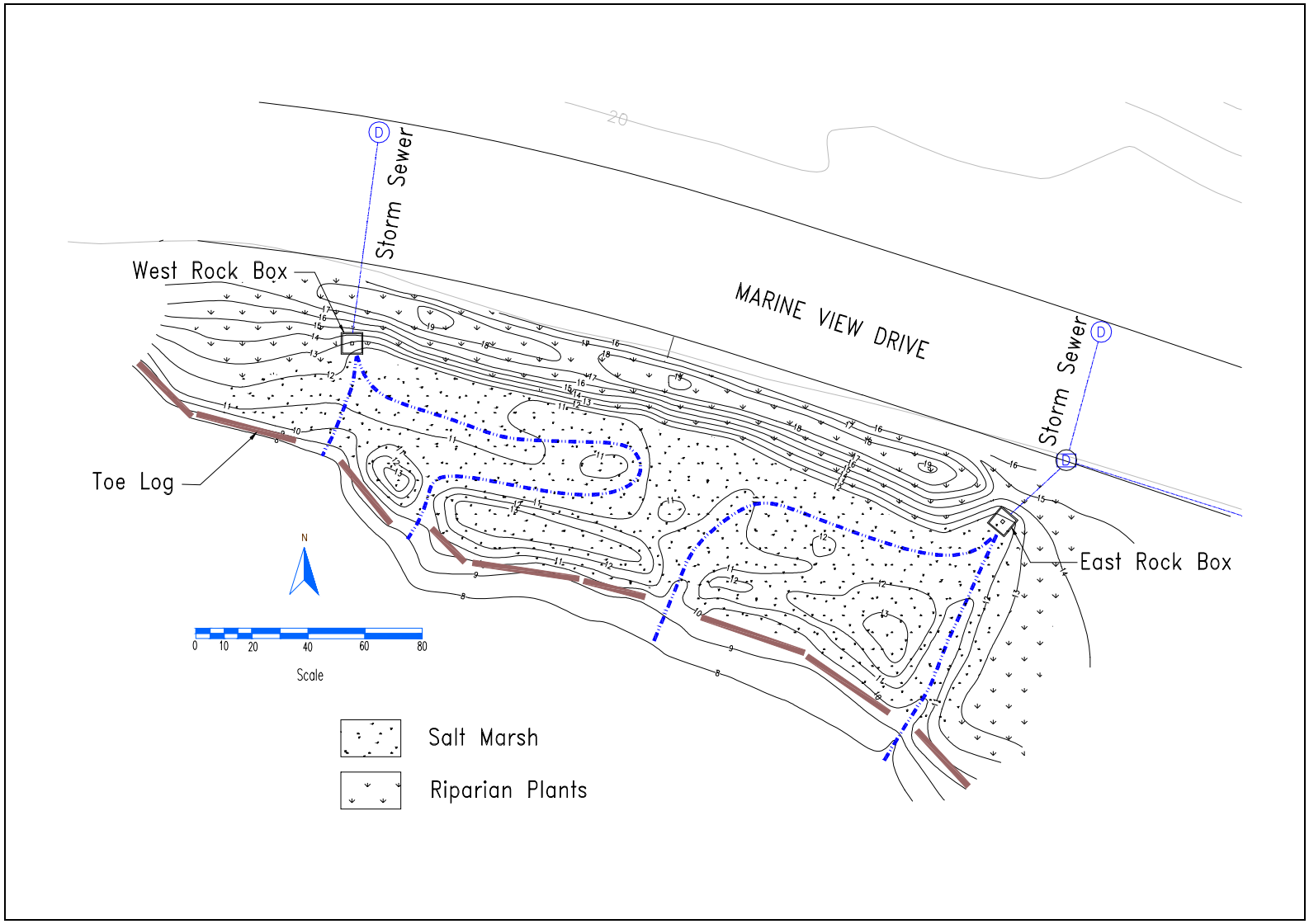

Figure 3 Site layout for Squally Beach Project.

Restoration Work

Restoration work at the Squally Beach site included clearing; debris removal; excavation and grading to reach design elevations; construction of rock outlet structures; installation of toe logs; hydroseeding and riparian planting. These tasks are individually described in the following sections.

Clearing, Debris Removal, Excavation, and Grading

The first actions at the Squally Beach site were to install erosion control and related preparatory measures in accordance with the plans, specifications and an erosion control plan developed for the site (Ridolfi, 2000). These measures included installation of:

- Silt fencing between the site and the mudflats.
- Temporary fencing along Marine View Drive to isolate the site.
- A rock driveway at the site entrance.

After the preparatory activities were finished, a tractor was used to mow the grass and shred the vegetation. Next, a large tracked excavator (trackhoe) was used to remove concrete and asphalt from a portion of the site. Subsequently, soil and fill materials were removed from the Squally Beach site to achieve design elevations. Excavation commenced on the west side of the site and proceeded toward the east. The lowest elevations for excavation were at approximately +8 feet MLLW. Grade control was maintained by establishing vertical control points in the project area and using a laser level to check grades on a daily basis.

Rock Box Structures

The rock box structures are intended to collect freshwater for distribution across the site and to dissipate energy that may be associated with high flows. The rock boxes are pre-cast concrete catch basins attached to the end of the concrete pipe. The top of each box was set flush to the ground surface and shallow channels were excavated to route freshwater from the outlet through the site. Cobbles were placed over the grates of the outlet structures to create a more natural appearance.

Salt Marsh Construction

Construction of the salt marsh at the Squally Beach site consisted of excavating to the appropriate subgrade elevations and placing organic-rich topsoil to serve as a growing media. Additionally, four tidal inlets were constructed to allow seawater to flow across the site and to provide drainage points for the diverted stormwater. Elevated berms were graded between the tidal outlets to help control the flow of water.

Toe Log Installation

Ten toe logs were installed parallel to the shoreline at the Squally Beach site to reduce the potential for erosion in areas with cut banks. The toe logs were 10 to 30 feet in length with diameters in the 1- to 2-foot range. Several of the logs were dragged from the adjacent mudflats. Other logs were scavenged from another nearby restoration project. The end of each toe log was secured with two Manta Ray™ anchors that were driven approximately 10 feet into the ground. The anchors have a hinged toggle that locks into the soil column as the anchor is retracted using a hydraulic device. Cables were looped through a shaft at the top of the anchor and secured around the logs.

Hydroseeding and Mulching

Hydroseeding technology was used to place grass and forb seed in upland areas of the site. The seed mixture was selected to include native species intended to have a meadow-like appearance when established. The seeds were embedded in a base of tackifier and nutrients to hold the seed in place and provide nourishment. After the seed mix was applied, a two-inch layer of sterile straw was blown over the upland areas to reduce the potential for erosion during the plant establishment period.

Table 1. Hydroseeding mixture.

Common Name	Latin Name	Percentage
Red Fescue	*Festuca rubra*	30
Barclay Perennial Rye	*Lolium perenne*	49
Sickle-Keeled Lupine	*Lupinus albicaulis*	10
Pearly Everlasting	*Anaphalis margaritacea*	8
White Yarrow	*Achillea millefolium*	3

Riparian Planting

Osborn Pacific Group served as landscape architects for the project. They prepared a planting plan that includes salt marsh vegetation and riparian or upland plants in buffer zones. The plants were selected to provide shelter and forage opportunities for fish and wildlife. An additional consideration was use of native species. The upland plants included a mix of trees and shrubs as indicated in Table 2. Volunteers installed upland plants on Nov. 18, 2000 at the Squally Beach site. Many of the volunteers were coordinated by Citizen's for a Healthy Bay; others were associated with local schools and universities.

Table 2. Riparian trees and shrubs.

TREES		
Scientific Name	**Common Name**	**# Plants**
Pseudotsuga menziesii	Douglas Fir	11
Tsuga heterophylla	Western Hemlock	5
SHRUBS		
Scientific Name	**Common Name**	**# Plants**
Cornus sericea	Red-Osier Dogwood	48
Mahonia nervosa	Oregon Grape	46
Holodiscus discolor	Oceanspray	20
Rosa nutkana	Nootka Rose	143
Salix hookeriana	Hooker's Willow	111
Gaultheria shallon	Salal	16
Symphoricarpos albus	Common Snowberry	69
Corylus cornuta	Hazelnut	18
Sambucus racemosa	Red Elderberry*	39
Ribes sanguineum	Red-Flowering Currant	48

Unanticipated Conditions

An area of contaminated soil and debris was encountered near the central portion of the site. A second area was encountered along the alignment of the concrete culvert on the east side of the site. Remtech ceased excavation in these areas when an odor was detected. Prior to identifying the source of the odor, two truckloads of potentially impacted soil had been hauled to an offsite staging area a few miles from the Squally Beach site. At the staging area the soil was segregated and covered with plastic pending analysis.

In the meantime, Ridolfi personnel sampled the onsite areas and stockpiled soil to characterize the materials and to help evaluate disposal options. Contamination seemed to be associated with a pea gravel-sized fill material that had a pronounced hydrocarbon odor. There may have been more than one type of material involved in a historical release because there was viscous, slippery oil in addition to a lighter

diesel-range fraction present. There was no indication of the source of the release, such as a buried tank or piping. The soil was sampled, excavated, and stockpiled on the east side of the site pending disposal. The Port of Tacoma arranged for waste characterization, transportation, and disposal of the soil. The soil was transported to a facility in Tacoma for treatment using low temperature thermal desorption.

The nature of the material in the bottom of the excavation pit (water-saturated and loose pea gravel) and the tidal influence precluded determining the vertical extent of contamination. Consequently, excavation was terminated, and the pit was backfilled with 4- to 6-inch rock to provide a stable subgrade for subsequent salt marsh construction.

Approximately 10 tons of creosote-treated wood was unearthed during excavation at the Squally Beach site. Most of this material was located in and around the location where the contaminated soil was discovered. These materials were segregated and characterized based on a sample of the treated wood analyzed for polycyclic aromatic hydrocarbons (PAHs) by EPA method 8270C. The analytical results are shown in Table 5. Based on the analytical results, the materials were placed in a roll-off bin and transported to the Tacoma landfill for disposal.

Near the end of the restoration project, it was determined that the post-and-wire fence was not long enough to prevent vehicles from entering the site. On the east side of the site, this condition had been exacerbated when brush was cleared to create a stockpile for contaminated soil. To remedy this situation, 10 extra posts were installed to extend the fence to the point where it intersected heavy growths of blackberry bushes. Coated cable, similar to the existing materials, was strung between the posts.

The remainder of the planting efforts is scheduled for the spring of 2001. Additionally, temporary irrigation systems will be installed at both sites to provide water for the upland plants until their roots are established.

Project Performance

The preliminary restoration objective of grading the sites to desired elevations has been achieved. It is too early to determine whether the ultimate goal of providing a functional habitat will be achieved. First, the salt marsh plants must be installed and allowed to grow. The plant community may take several years to develop, and it may progress in a trajectory different than envisioned in the design. In addition to development of a floral community, it is anticipated that a diverse faunal community will develop at each site as overall habitat conditions improve. Again, faunal development may take years to achieve, and monitoring will be required to document the progression.

Project Costs

Project costs for these projects were controlled primarily by the amount of excavation required to reach appropriate elevations for restoration of salt marsh vegetation. The construction cost was $115,000. Change orders for unanticipated conditions increased the final project cost by approximately 14 percent. NOAA had established a contingency fund for the restoration efforts and it was sufficient to cover the change orders. Consequently, progress on the project was not impeded.

Lessons Learned

In general, the restoration projects proceeded within normal limits for projects of this type. The work was essentially completed as planned. The project schedule and budget increased slightly because of unforeseeable site conditions and circumstances. These positive results can be attributed at least in part to a strong working relationship between NOAA as the owner, Ridolfi as the design engineer providing field oversight, and Remtech as the contractor. An important part of the working relationship was frequent, ongoing communication between field personnel (both contractor and oversight engineer) and office staff regarding conditions in the field compared to construction plans.

The following list provides areas where modifications in contract documents or other items might contribute to smoother project implementation.

1. Cross-sections provide a precise means of conveying desired site conditions. The construction plans should emphasize that the contractor should use the cross-sections to direct grading of the site.

2. For larger sites, it may be useful to include a grid system in the survey requirements. This would entail establishing a regular grid on 100 to 500 foot intervals, depending on the size of the site, to facilitate locating features in the field.

3. Weighing soil for disposal should be considered as a means of quantifying this type of material. Remtech was somewhat confused by this pay item. Their personnel were counting trucks and they anticipated being paid on this basis. (The contract stated that soil excavation would be paid on an "in-place" basis.)

4. Obtaining a "rate sheet" from the contractor at bid time can be used as a means of administering contract modifications and change orders during construction. Rate sheets may also help when evaluating and comparing bids.

Next Steps

The next step is to plant emergent salt marsh vegetation at the site as identified in Table 3. Volunteers will be enlisted to install salt marsh plants at the Squally Beach site late in the spring of 2001. A temporary irrigation system is planned to provide water for the upland plants. For logistical reasons, this system will be installed under contract to the City of Tacoma.

After the plants are installed, a monitoring program will be instituted to document project performance. This program will include physical and biological monitoring to evaluate whether the sites perform as intended. This will include measurement of parameters to evaluate form such as elevation, slope and intertidal area. Additionally, measurements will be made to evaluate function such as the density and diversity of plants, fish, insects, and macroinvertebrates. This monitoring program will be conducted by the Trustees as part of a wider effort to evaluate restoration effectiveness in Commencement Bay.

Table 3. Emergent salt marsh vegetation.

SALT MARSH PLANTS		
Scientific Name	**Common Name**	**# Plants**
Carex lyngbyei	Lyngby's Sedge	632
Distichlis spicata	Salt Grass	1,742
Jaumea carnosa	Fleshy Jaumea	374
Salicornia virginia	Pickleweed	1,017
Scirpus Americanus	American 3-Square Rush	234
Triglochim martimum	Seaside Arrow Grass	224
Deschampsia caespitosa	Tufted Hairgrass	1,459

Acknowledgements

The support of NOAA working on behalf of the Commencement Bay Natural Resource Trustees made this project possible. The project ultimately benefited from constructive input by the Trustees and the public. Thanks are also due to volunteers, coordinated in large part by the Citizen's for a Healthy Bay, who cheerfully installed plants at the site on a cool November day.

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